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Effect of dietary protein source and *Saccharina latissima* on milk fatty acid profiles and bromoform

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LIMITLESS **POTENTIAL** | LIMITLESS **OPPORTUNITIES** | LIMITLESS **IMPACT** *k*

INTRODUCTION

Ruminants production

shortage of feed protein sources ⟷ **high-quality food and its potential health benefits**

(Kim et al., 2019, Annu Rev Anim Biosci 7:221-243)

Protein source:

- Rapeseed meal (RSM)

  - the reduction of use of pesticides in the UK and EU :threats in rapeseed yields in the UK and European Union
  - rapeseed varieties are also high in glucosinolates: posing a risk to food safety

- Wheat distillers' grains (WDG)

  - by-products of the ethanol industry, commonly used as a feed ingredient in dairy cow diets
  - at high inclusion levels to up to 22.5% of diet dry matter without affecting dry matter intake and milk yield

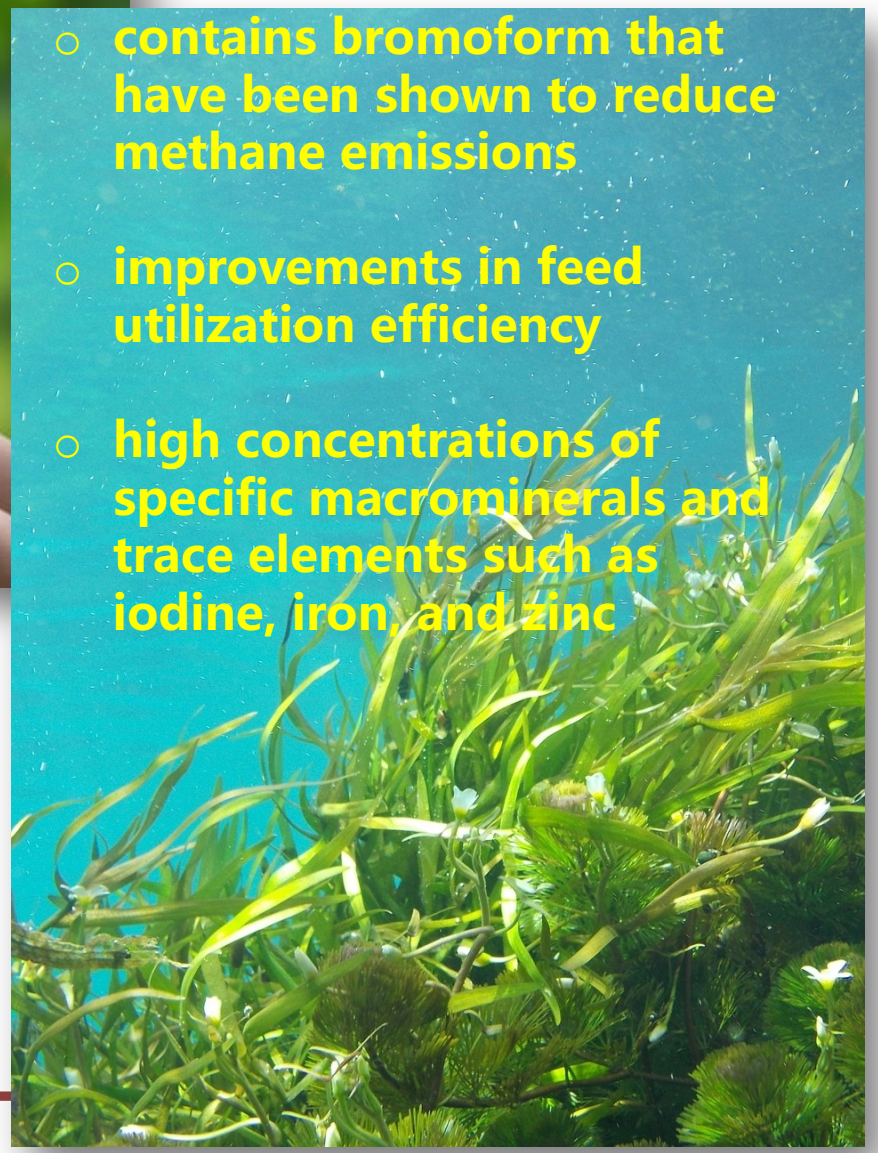
INTRODUCTION

- **sustainability of livestock production and climate change**

- **diet is the most influential driver of milk fatty acid profile**
  - **algae (Schizochytrium sp.) supplementation (43.0 g/kg of dry matter intake), provided via a rumen fistula, increased concentrations of t10 C18:1, VA, RA, t9c11 CLA, and DHA**

Boeckaert et al., 2008, J Dairy Sci 91:4714-4727

Macroalgae/seaweed



- **contains bromoform that have been shown to reduce methane emissions**
- **improvements in feed utilization efficiency**
- **high concentrations of specific macrominerals and trace elements such as iodine, iron, and zinc**

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INTRODUCTION

Objectives

Understand the effect, and interaction of, wheat distillers' grains (WDG) and *Saccharina latissima* on milk quality and safety

- **Investigate the effect of substituting RSM with WDG as a protein source in dairy rations, including *Saccharina latissima* as a supplement, as well as the potential interaction between these two feeding practices on the FA profiles of milk.**

- **explore the extent of the transfer of bromoform from feed to milk, to ensure that feeding S. latissima at the given amounts would not pose any threats to food safety.**

MATERIALS AND METHODS

- ✓ 16 multiparous Holstein cows (35 kg/d)
- ✓ 4×4 Latin square change-over design: 4-week experimental periods.
- ✓ C-WDG, S-WDG , C-RSM , S-RSM

➢ Protein Sources

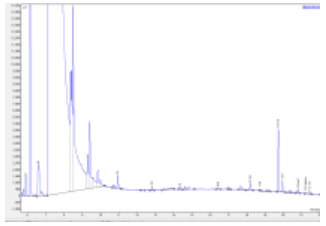
wheat distillers' grains

rapeseed meal

➢ Seaweed

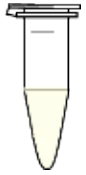
35.7 g/cow/d

➢ Dairy cow



➢ gas chromatograph

Feed



Milk

➢ Feed intake and milk output

- Bromoform
- 90 Fatty acids

7890A GC coupled to a 5975C Inert MS detector

➢ Transfer efficiency

- *Reduced linoleic acid efficiency*

➢ Human healthy concerns

- *Concentrations of beneficial and non-beneficial FA*
- *atherogenicity and thrombogenicity indices*
- *bromoform contamination*

- ✓ A linear mixed model
- ✓ Tukey's Honest Significant Difference

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RESULTS

❖ The fatty acid composition and bromoform concentrations of the experimental diets

	Seaweed			Protein source			Seaweed × concentrate			
Parameters	C	S		WDG	RSM		C-WDG	C-RSM	S-WDG	S-RSM
Fatty acid profile (g/kg diet dry matter)										
C16:0	4.10	4.13		4.48	3.75		4.46	3.75	4.50	3.75
C18:1 c9 (OA)	2.08	2.09		1.96	2.21		1.94	2.22	1.99	2.20
C18:2 c9c12 (LA)	4.59	4.63		5.47	3.75		5.43	3.76	5.51	3.75
C18:3 c9c12c15 (ALA)	6.69	6.68		6.72	6.65		6.76	6.63	6.69	6.67
Total fatty acids	21.1	21.2		21.2	21.2		21.1	21.2	21.2	21.1
Bromoform (µg/kg)	48.6	50.4		51.6	47.4		50.7	46.5	52.6	48.3

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Milk individual fatty acids profiles

	Seaweed				Protein source			
(g/kg total FA)	C	S	SEM	p-value	WDG	RSM	SEM	p-value
C12:0	36.3	37.1	0.99	0.388	35.9	37.5	0.99	0.045
C14:0	118	120	2.5	0.315	117	121	2.5	0.022
C16:0	367	371	7.9	0.494	362	376	7.9	0.007
C18:0	80.9	78.4	2.48	0.242	82.8	76.4	2.48	0.005
OA (C18:1 c9)	161	158	5.0	0.414	163	155	5.0	0.030
VA (C18:1 t11)	8.00	8.15	0.533	0.647	8.71	7.45	0.533	＜0.001
LA (C18:2 c9c12)	12.6	12.2	0.49	0.240	14.1	10.8	0.49	＜0.001
RA (CLA9, C18:2 c9t11)	4.62	4.63	0.403	0.927	4.91	4.35	0.403	＜0.001
ALA	4.31	4.32	0.302	0.874	4.45	4.18	0.302	0.012
EPA	0.49	0.47	0.029	0.455	0.48	0.49	0.029	0.529
DPA	0.72	0.70	0.048	0.247	0.72	0.70	0.048	0.461
DHA	0.04	0.04	0.005	0.191	0.04	0.04	0.005	0.060

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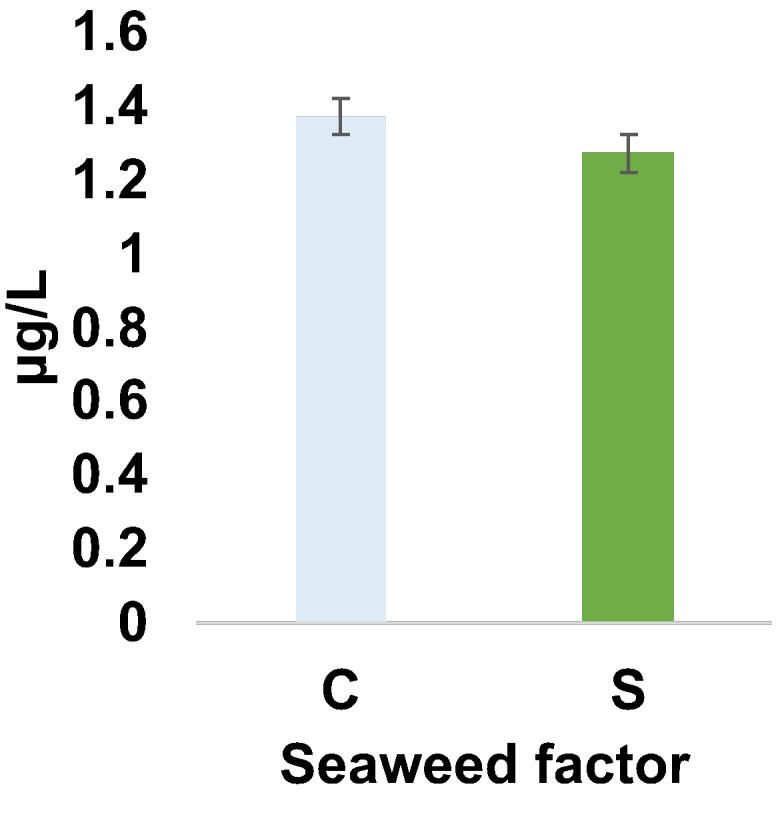
Group FA

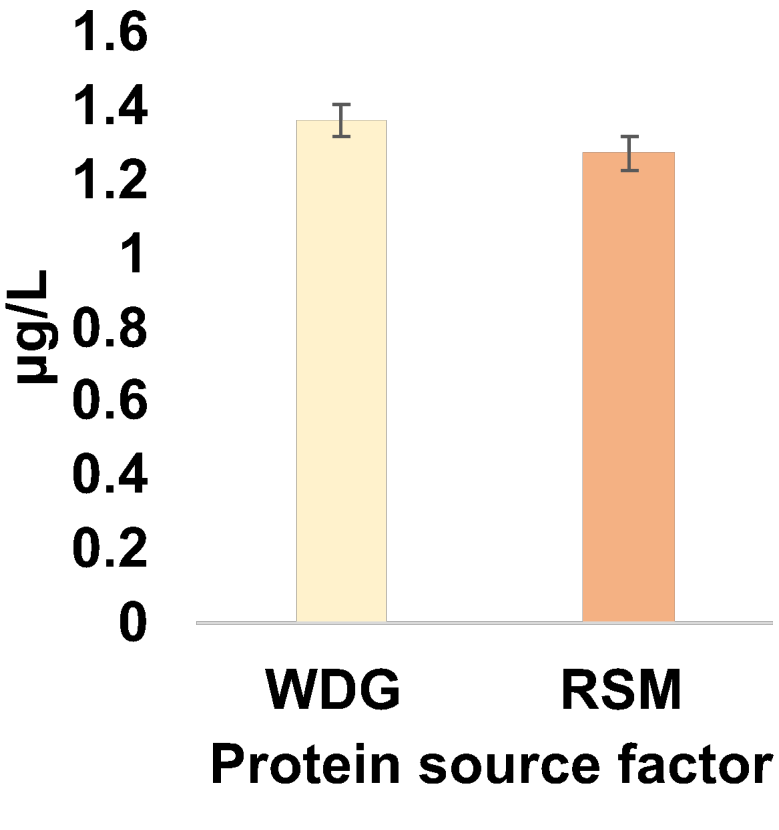
Human health related indices

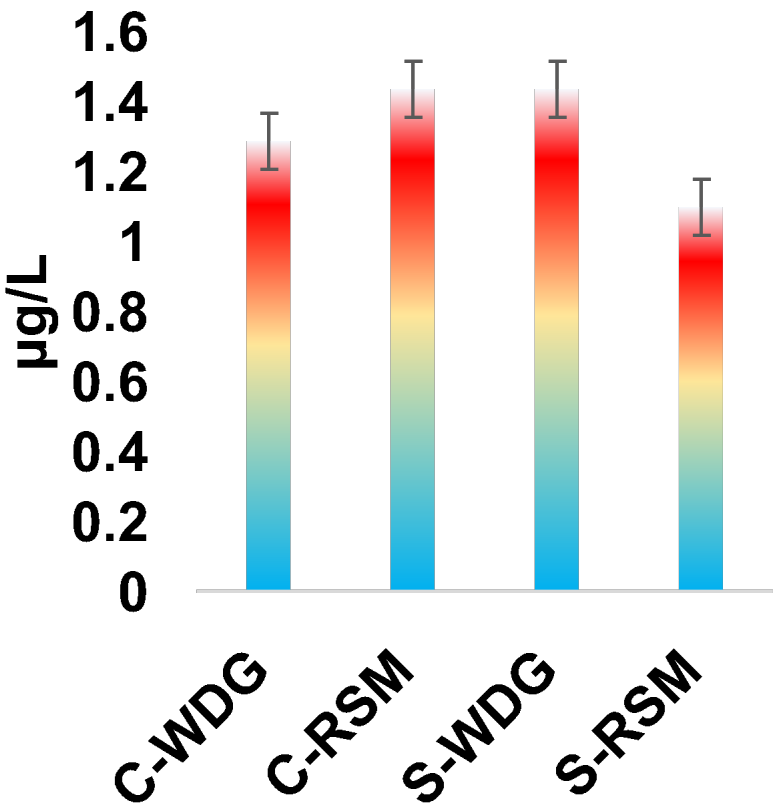
FA groups (g/kg total FA)	C	S	SEM	p		WDG	RSM	SEM	p
SFA	733	737	6.3	0.412		729	741	6.3	0.006
MUFA	232	229	5.5	0.456		235	227	5.5	0.044
PUFA	34.5	33.9	0.95	0.262		36.3	32.0	0.95	＜0.001
n-3	8.58	8.51	0.373	0.678		8.60	8.49	0.373	0.535
n-6	16.1	15.6	0.60	0.177		17.6	14.1	0.60	＜0.001
n-6:n-3 ratio	18.9	18.6	1.02	0.507		20.6	16.9	1.02	＜0.001
trans FA	30.5	29.9	0.66	0.259		30.9	29.5	0.66	0.013
trans FA (exc. VA)	30.2	29.6	0.65	0.277		30.6	29.1	0.65	0.010
AI	33.3	34.1	1.04	0.301		32.4	35.0	1.04	0.002
TI	36.9	37.5	1.13	0.417		36.2	38.1	1.13	0.019

•Atherogenicity index = (C12:0 + (4 × C14:0) + C16:0) / (MUFA + PUFA), as described in Średnicka-Tober et al. (2016).
•Thrombogenicity index= (C14:0 + C16:0 + C18:0) / (0.5 × MUFA) + (0.5 × n-6) + (3×n-3) + (n-3:n-6) as described in Średnicka-Tober et al. (2016).

Bromoform







❖ No significant difference among them

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Transfer rate

	C	S	SEM	p		WDG	RSM	SEM	p
Linoleic acid									
Intake (g/d)	83.5	83.2	3.43	0.722		98.4	68.4	3.43	＜0.001
Output (g/d)	11.4	10.9	0.78	0.192		12.3	10.0	0.78	＜0.001
Transfer rate (% intake)	**14.0**	**13.3**	**1.12**	**0.157**		**12.5**	**14.8**	**1.12**	**＜0.001**
α-linolenic acid									
Intake (g/d)	124	122	10.4	0.535		123	123	10.4	0.988
Output (g/d)	3.93	3.89	0.456	0.821		3.94	3.87	0.456	0.606
Transfer rate (% intake)	3.26	3.18	0.346	0.461		3.25	3.19	0.346	0.605
Bromoform									
Intake (μg/d)	818.7	821.9	96.03	0.981		847.9	792.7	96.03	0.686
Output (μg/d)	26.9	28.2	4.71	0.850		27.7	27.4	4.71	0.960
Transfer rate (% intake)	4.56	4.44	0.780	0.919		4.22	4.78	0.780	0.611

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CONCLUSION

- Feeding WDG to dairy cows improved the milk FA profiles
- Increasing the concentrations of the nutritionally beneficial polyunsaturated fatty acids, rumenic acid, linoleic acid and α-linolenic acid
- Reducing the concentration of the nutritionally undesirable saturated fatty acids.
- Feeding *S. latissima* at 35.7 g/cow/d does not affect milk fatty acid profiles and does not pose any risks around bromoform contamination of milk

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